Claims:

What is claimed is:

1. A spin injection device characterized in that it comprises a spin injection part having a spin polarizing part and an injection junction part,

and SyAF having a first magnetic layer and a second magnetic layer having different magnitudes of magnetization, and magnetically coupled together antiparallel to each other via a nonmagnetic layer, wherein:

said SyAF and said injection junction part are bonded, and

a spin polarization electron is injected from said spin injection part, and magnetization of said first and second magnetic layers is reversed while maintained in antiparallel state.

2. The spin injection device as set forth in claim 1, characterized in that the injection junction part of said spin injection part is either a nonmagnetic conductive layer or a nonmagnetic insulating layer.

3. The spin injection device as set forth in claim 1 or claim 2, characterized in that said spin polarization electron is capable of spin conservation conduction or tunnel junction at the injection junction part of said spin injection part.

4. The spin injection device as set forth in any one of claims 1 - 3, characterized in that the spin polarization part of said spin injection part is a ferromagnetic layer.

5. The spin injection device as set forth in any one of claims 1 - 3, characterized in that the spin polarization part of said spin injection part is provided in contact with an antiferromagnetic layer that fixes the spin of a ferromagnetic layer.

6. The spin injection device as set forth in any one of claims 1

- 5, characterized in that the aspect ratio of the first and the second magnetic layers of SyAF in contact with the injection junction part of said spin injection parts is less than 2.

7. A spin injection magnetic apparatus characterized in that it comprises a free layer having the first and the second magnetic layers coupled together magnetically antiparallel to each other via a nonmagnetic layer, and in which magnitudes of magnetization are different, and the magnetization of said first and the second magnetic layers is capable of magnetization reversal while maintaining the antiparallel state, and

a ferromagnetic fixed layer tunnel-junctioned with said free layer via an insulating layer, wherein:

said ferromagnetic fixed layer and said free layer are made to be a ferromagnetic spin tunnel junction.

8. The spin injection magnetic apparatus as set forth in claim 7, characterized in that it is provided with, in addition to the above-mentioned aspects, a spin injection part having an injection junction part connected to said free layer and a spin polarization part.

9. The spin injection magnetic apparatus as set forth in claim 8, characterized in that the injection junction part of said spin injection part is either a nonmagnetic conductive layer or a nonmagnetic insulating layer.

10. The spin injection magnetic apparatus as set forth in claim 8 or claim 9, characterized in that said spin polarization electron is capable of spin conservation conduction or tunnel junction at the injection junction part of said spin injection part.

11. The spin injection magnetic apparatus as set forth in any one of claims 8 - 10, characterized in that the spin polarization part of said spin injection part is a ferromagnetic layer.

12. The spin injection magnetic apparatus as set forth in any one of claims 8 - 10, characterized in that the spin polarization part of said spin injection part is provided in contact with an antiferromagnetic layer that fixes the spin of a ferromagnetic layer.

13. The spin injection magnetic apparatus as set forth in any one of claims 7 - 12, characterized in that the aspect ratio of the first and the second magnetic layers of the free layer in contact with the injection junction part of said spin injection part is less than 2.

14. The spin injection magnetic apparatus as set forth in any one of claims 8 - 13, characterized in that said spin injection part is word line.

15. A spin injection device characterized in that:

in a spin injection device comprising a spin injection part having a spin polarization part including a ferromagnetic fixed layer and an injection junction part of a nonmagnetic layer, and

a ferromagnetic free layer provided in contact with said spin injection part, wherein:

said nonmagnetic layer is made of an insulator or a conductor,

a nonmagnetic layer is provided on the surface of said ferromagnetic free layer, and

an electric current flows in the direction perpendicular to the film surface of said spin injection device in order to reverse a magnetization of said ferromagnetic free layer.

16. The spin injection device as set forth in claim 15, characterized in that said ferromagnetic free layer is made of Co or Co alloy, a nonmagnetic layer provided on the surface of said ferromagnetic free layer is a Ru layer, and its film thickness is 0.1 - 20 nm.

17. A spin injection device, characterized in that:

in a spin injection device comprising a spin injection part

having a spin polarization part including a ferromagnetic fixed layer and an injection junction part of a nonmagnetic layer, and

a ferromagnetic free layer provided in contact with said spin injection part, wherein:

said nonmagnetic layer is made of an insulator or a conductor,

a nonmagnetic and a ferromagnetic layers are provided on the surface of said ferromagnetic free layer, and

an electric current flows in the direction perpendicular to the film surface of said spin injection device in order to reverse a magnetization of said ferromagnetic free layer.

18. The spin injection device as set forth in claim 17, characterized in that said ferromagnetic free layer and said ferromagnetic layer are made of Co or Co alloy, a nonmagnetic layer provided on the surface of said ferromagnetic free layer is a Ru layer, and its film thickness is 2 - 20 nm.

19. The spin injection magnetic apparatus, characterized in that it uses the spin injection device as set forth in any one of said claims 15 - 18.

20. The spin injection magnetic memory device, characterized in that it uses the spin injection device as set forth in any one of said claims 15 - 18.

21. A magnetic thin film, characterized in that:

it comprises a substrate, and $Co_2Fe_xCr_{1-x}Al$ thin film formed on said substrate, and said $Co_2Fe_xCr_{1-x}Al$ thin film has either of structures $L2_1$, B2, and A2, and in which x is $0 \leqq x \leqq 1$.

22. The magnetic thin film as set forth in claim 21, characterized in that said $Co_2Fe_xCr_{1-x}Al$ thin film is formed without heating said substrate.

23. The magnetic thin film as set forth in claim 21 or claim 22,

characterized in that said substrate is either thermally oxidized Si, glass, MgO single crystal, GaAs single crystal, or Al_2O_3 single crystal.

24. The magnetic thin film as set forth in any one of claims 21 - 23, characterized in that a buffer layer is provided between said substrate and said $Co_2Fe_xCr_{1-x}Al$ thin film.

25. The magnetic thin film as set forth in any one of claims 21 - 24, characterized in that said buffer layer is made of at least either one of Al, Cu, Cr, Fe, Nb, Ni, Ta, and NiFe.

26. A tunnel magnetoresistance effect device, characterized in that:

in the tunnel magnetoresistance effect device having a plurality of ferromagnetic layers on the substrate, at least one of the ferromagnetic layers is $Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) magnetic thin film having either one of structures $L2_1$, B2, and A2.

27. The tunnel magnetoresistance effect device as set forth in claim 26, characterized in that said ferromagnetic layer consists of a fixed and a free layers, and said free layer is $Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) magnetic thin film having either one of structures $L2_1$, B2, and A2.

28. The tunnel magnetoresistance effect device as set forth in claim 26 or claim 27, characterized in that said $Co_2Fe_xCr_{1-x}Al$ thin film is formed without heating said substrate.

29. The tunnel magnetoresistance effect device as set forth in any one of claims 26 - 28, characterized in that a buffer layer is provided between said substrate and said $Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) thin film.

30. The tunnel magnetoresistance effect device as set forth in claim 29, characterized in that said substrate is either thermally

oxidized Si, glass, MgO single crystal, GaAs single crystal, or Al_2O_3 single crystal.

31. The tunnel magnetoresistance effect device as set forth in claim 29, characterized in that said buffer layer is made of at least either one of Al, Cu, Cr, Fe, Nb, Ni, Ta, and NiFe.

32. A giant magnetoresistance effect device, characterized in that:

in the giant magnetoresistance effect device having a plurality of ferromagnetic layers on a substrate, at least one of the ferromagnetic layers consists of $Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) magnetic thin film having either one of structures $L2_1$, B2, and A2, and has the structure in which electric current flows in the direction perpendicular to film surface.

33. The giant magnetoresistance effect device as set forth in claim 32, characterized in that said ferromagnetic layer consists of a fixed and a free layers, and said free layer is $Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) magnetic thin film having either one of structures $L2_1$, B2, and A2.

34. The giant magnetoresistance effect device as set forth in claim 32 or claim 33, characterized in that said $Co_2Fe_xCr_{1-x}Al$ thin film is formed without heating said substrate.

35. The giant magnetoresistance effect device as set forth in any one of claims 32 - 34, characterized in that a buffer layer is provided between said substrate and said $Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) thin film.

36. The giant magnetoresistance effect device as set forth in any one of claims 32 - 35, characterized in that said substrate is either thermally oxidized Si, glass, MgO single crystal, GaAs single crystal, or Al_2O_3 single crystal.

37. The giant magnetoresistance effect device as set forth in claim 35, characterized in that said buffer layer is made of at least either one of Al, Cu, Cr, Fe, Nb, Ni, Ta, and NiFe.

38. A magnetic device, characterized in that:

$Co_2Fe_xCr_{1-x}Al$ ($0 \leqq x \leqq 1$) magnetic thin film having either of structures $L2_1$, B2, and A2 is formed on a substrate.

39. The magnetic device as set forth in claim 38, characterized in that a free layer uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device consisting of said $Co_2Fe_xCr_{1-x}Al$ ($0 \leqq x \leqq 1$) magnetic thin film.

40. The magnetic device as set forth in claim 38 or claim 39, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device manufactured without heating a substrate.

41. The magnetic device as set forth in any one of claims 38 - 40, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device in which a buffer layer is provided between said substrate and said $Co_2Fe_xCr_{1-x}Al$ ($0 \leqq x \leqq 1$) thin film.

42. The magnetic device as set forth in any one of claims 38 - 41, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device in which said substrate is either thermally oxidized Si, glass, MgO single crystal, GaAs single crystal, or Al_2O_3 single crystal.

43. The magnetic device as set forth in claim 41, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device in which said buffer layer is made of at least either one of Al, Cu, Cr, Fe, Nb, Ni, Ta, and NiFe.

44. A magnetic head, characterized in that:

$Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) magnetic thin film having either of structures $L2_1$, B2, and A2 is formed on a substrate.

45. The magnetic head as set forth in Claim 44, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device in which the free layer is said $Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) magnetic thin film.

46. The magnetic head as set forth in claim 44 or claim 45, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device manufactured without heating said substrate.

47. The magnetic head as set forth in either of claims 44 - 46, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device in which a buffer layer is provided between said substrate and said $Co_2Fe_xCr_{1-x}Al$ (where $0 \leqq x \leqq 1$) thin film.

48. The magnetic head as set forth in either of claims 44 - 47, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device in which said substrate is either thermally oxidized Si, glass, MgO single crystal, GaAs single crystal, or Al_2O_3 single crystal.

49. The magnetic head as set forth in claim 47, characterized in that it uses said tunnel magnetoresistance effect device or giant magnetoresistance effect device in which said buffer layer is made of at least either one of Al, Cu, Cr, Fe, Nb, Ni, Ta, and NiFe.

50. The magnetic recording apparatus, characterized in that it uses said magnetic head as set forth in any one of claims 44 to 49.